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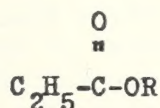
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PRELIMINARY TESTS OF SOME ESTERS OF PROPIONIC ACID

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Seventy-one esters of propionic acid were tested as insecticides in the laboratory of this Bureau, at Anaheim, Calif., from March to December 1951. These esters are represented by the general formula,



where R is an aryl or alkyl group with or without substituents. All the compounds were prepared by reacting alcohols and phenols with propionic acid or propionic anhydride under suitable conditions. They were tested against three or four species of insects and one spider mite.

The following species were used:

Armyworm (Psuedaletia unipuncta (Haw.))
Celery leaf tier (Phlyctaenia rubigalis (Guen.))
Large milkweed bug (Oncopeltus fasciatus (Dall.))
Pea aphid (Macrosiphum pisi (Harris))
Salt-marsh caterpillar (Estigmene acrea (Drury))
Two-spotted spider mite (Tetranychus bimaculatus Harvey)

The insects were reared in the laboratory, and the two-spotted spider mites were collected in the field.

In each test that the species was used, the following number of individuals were tested: 30 larvae of the armyworm and the salt-marsh caterpillar, 24 larvae of the celery leaf tier, 20 milkweed bugs, and an average of 29 aphids and 57 mites. The test samples were either sprayed or dusted on foliage, and the foliage was placed in petri dishes with larvae of the armyworm, the celery leaf tier, and the salt-marsh caterpillar. Large milkweed bugs were placed in 8-cm. crystallizing dishes and dusted or sprayed. Untreated food and water were supplied and the dishes were covered with coarse muslin. The pea aphids were removed from an infested plant for treating, and were kept during the test period on potted Windsor bean plants in cloth-capped glass battery jars 7 inches in diameter. The two-spotted spider mites were dusted or sprayed while on castor bean leaves and were kept in battery jars.

The samples were first tested for insecticidal action. Those tested as dusts were diluted to 10 percent in pyrophyllite and were in good physical condition for dusting. Those tested as sprays or dips were diluted to 5 percent or less on a weight/volume basis in acetone or water.

Some materials causing insect mortalities of 75 percent or higher as dusts or sprays were applied as sprays to the leaves of five growing plants to determine whether they would be too injurious to green foliage for practical use against leaf-eating insects. The sprays contained 1 percent of the active ingredient and were applied to both sides of the leaves until there was run-off.

The results of tests with three insecticides of known value against certain insects, made for comparative purposes, are presented in tables 1 and 2.

Fifty-six compounds caused greater than 74 percent mortality to one or more species of insects when tested as sprays or dips, as shown in table 3. 2,4-Dinitro-6-biphenyl, pentabromophenyl, and pentachlorophenyl propionates were the most effective acaracides, all causing over 75 percent mortality of the two-spotted spider mite when tested as 0.05-percent sprays. Against the armyworm, 2,4-dinitro-6-biphenyl and pentachlorophenyl propionates were effective as 0.5-percent sprays, thus making these two compounds the only ones effective as low-concentration sprays against more than one species of insect. *Orthocentrus* and *Orthocentrus* phenyl propionates were effective when used as 0.5-percent sprays against the large milkweed bug and *p*-bromophenyl, *p*-chlorophenyl, and 2,4,5-trichlorophenyl propionates were effective as 0.5-percent dips against the pea aphid.

Thirteen compounds caused greater than 74 percent mortality to one or more species of insects when tested as 10-percent dusts, as shown in table 4. Three compounds were found to be effective against the armyworm and the two-spotted spider mite. They were 2-biphenyl, pentachlorophenyl, and 2,3,4,6-tetrachlorophenyl propionates. 6-tert-Butyl-*m*-tolyl propionate was also effective against the two-spotted mite. The following compounds were effective against larvae of the celery leaf tier: Dipropionates of 2,4'-dihydroxybenzophenone, 4,4'-dihydroxybenzophenone, and 1,5-naphthalenediol, and 2-bromo-4-tert-butylphenyl, *p*-cyclohexylphenyl, and *m*-ethylphenyl propionates. One hundred percent mortalities of second-instar pea aphids resulted from the use of 2-naphthyl propionate and *p*-nitrophenyl propionate. The latter was also effective as a 5-percent dust. None of the compounds tested as dusts against the large milkweed bug were effective.

Compounds causing less than 75 percent mortality of any species of insect when tested as 10-percent dusts are given in table 5, and those causing less than 75 percent mortality when used as acetone sprays are given in table 6.

Of 24 effective compounds tested for phytotoxicity, 2,4,5-trichlorophenyl propionate was the only one that caused moderate to severe injury. Severe injury resulted to foliage of beans, beets, and corn, and moderate injury to cabbage. o-Bromophenyl propionate caused slight injury to radish foliage, and p-bromophenyl propionate caused slight injury to corn foliage.

Table 1.--Effectiveness of three insecticides tested as dusts against various species of insects to be used as standards for comparing results obtained with new compounds

Insecticide ^{1/}	Insect	Stage	Feeding	Average percent kill after 2 days
<u>Percent</u>				
DDT	1.0 Armyworm	Third instar	None	100
	.1 do.	do.	Moderate	27
	.5 Celery leaf tier	do.	Slight	92
Lindane	.125 Large milkweed bug	Fourth instar	-	100
Parathion	.2 Large milkweed bug	Fourth instar	-	50 ^{2/}
	.005 Pea aphid	Adult	-	68 ^{2/}
	.001 do.	Second instar	-	31 ^{2/}
	.1 Two-spotted spider mite	Nymphs and adults	-	96
	.05 do.	Adults	-	18

^{1/} 1 gram dispersed in vacuum duster.
^{2/} After 1 day.

Table 2.--Effectiveness of three insecticides tested as sprays or dips against various species of insects to be used as standards for comparing results obtained with new compounds

Insecticide	Percent concentration		Insect	Stage	Average percent kill after 2 days
	In acetone	In water			
DDT	0.05	-	Armyworm	Third instar	95
	-	0.1	Pea aphid	Adult	28
	1	-	Salt-marsh caterpillar	Third instar	95
Lindane	.01	-	Large milkweed bug	Fourth instar	85
	.05	-	Armyworm	Third instar	93
Parathion	-	.0005	do.	do.	75
	.1	-	Large milkweed bug	Fourth instar	95
	-	.0005	do.	do.	63 ² / ₁
	.01	-	Pea aphid	Adult	80 ² / ₁
	.005	-	do.	do.	95
	-	.00025 ¹ / ₁	do.	do.	72 ² / ₁
	-	.00001 ¹ / ₁	do.	do.	100
	.005	-	Two-spotted spider mite	Adult	95
	-	.0005	do.	Nymphs and adults	92
	-	.0005	do.	Adults	78

1/ Dipped.
2/ After 1 day.

Table 3.--Propionates causing more than 74 percent mortality of one or more species of insects when tested as sprays or dips

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
<u>In water</u>						
m-Cresol	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	70
	1	Pea aphid	Adult	-	100 1/2	-
	.5	do.	do.	-	46	-
	1	Two-spotted spider mite	do.	-	-	78
	.5	do.	do.	-	-	46
o-Cresol	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	64
	1	Pea aphid	Adult	-	100 1/2	-
	.5	do.	do.	-	77 1/2	-
	.1	do.	do.	-	39 1/2	-
	1	Two-spotted spider mite	do.	-	-	78
p-Cresol	.5	do.	do.	-	-	40
	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	100
	.5	do.	do.	-	-	25
	1	Pea aphid	Adult	-	100 1/2	-
	.5	do.	do.	-	86 1/2	-
p-Cresol, alpha-phenyl-	.1	do.	do.	-	19 1/2	-
	1	Two-spotted spider mite	do.	-	-	100
	.5	do.	do.	-	-	63
	1	Armyworm	Third instar	Slight	-	3
	1	Large milkweed bug	Fourth instar	-	-	85
	.5	do.	do.	-	-	10

				74 ¹ / ₂	
Pea aphid	Adult	-	-	-	-
Two-spotted spider mite	do.	-	-	-	100
do.	do.	-	-	-	100
do.	do.	-	-	-	93
do.	do.	-	-	-	47

In acetone

<u>o</u> -Cresol, 4-chloro-	5	Armyworm	Third instar	Slight	87
	1	do.	do.	Much	0
	5	Large milkweed bug	Fourth instar	-	10
	5	Pea aphid	Adult	-	67
	5	Two-spotted spider mite	do.	-	100
	1	do.	do.	-	100
	.5	do.	do.	-	80

o-Cresol, 6-Chloro-

	5	Armyworm	Third instar	None	100
	1	do.	do.	Much	0
	5	Large milkweed bug	Fourth instar	-	10
	5	Pea aphid	Adult	-	7
	5	Two-spotted spider mite	do.	-	88
	1	do.	do.	-	33

In water

<u>m</u> -Cresol, 4,6-di-tert-butyl-	1	Armyworm	Third instar	Slight	43
	1	Large milkweed bug	Fourth instar	-	13
	1	Pea aphid	Adult	-	-
	.5	do.	do.	-	-
	1	Two-spotted spider mite	do.	-	100
	.5	do.	do.	-	100
	.1	do.	do.	-	14 ¹ / ₂

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
<u>In acetone</u>						
<u>p</u> -Cresol, 2-nitro-	5	Armyworm	Third instar	Slight	-	97
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	-	0
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	0
<u>m</u> -Cresol, 6-tert-butyl-	5	Armyworm	Third instar	None	-	100
	1	do.	do.	Much	-	20
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	-	21
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	78
	.1	do.	do.	-	-	0
<u>p</u> -Cresol, 2-tert-butyl-	1	Armyworm	Third instar	Moderate	-	17
	5	Large milkweed bug	Fourth instar	-	-	10
	5	Two-spotted spider mite	Adult	-	-	98
	1	do.	do.	-	-	0
Cyclohexanethanol	5	Armyworm	Third instar	None	-	100
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	10
	5	Pea aphid	Adult	-	-	17
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	83
	.5	do.	do.	-	-	69

In water

Cyclohexanol	1	Armyworm	Third instar	Moderate	-	7
	1	Large milkweed bug	Fourth instar	-	-	0
	1	Pea aphid	Adult	-	-	100
	.5	do.	do.	-	81	-
	.1	do.	do.	-	27	-
	1	Two-spotted spider mite	Nymphs and adults	-	-	53

In acetone

Cyclohexanol, 2-cyclohexyl-	5	Armyworm	Third instar	Moderate	-	47
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	-	70
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	88
	.5	do.	do.	-	-	28

Cyclohexanol, 4-cyclohexyl-	5	Armyworm	Third instar	Moderate	-	43
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	-	100
	1	do.	do.	-	-	45
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	66

Cyclohexanol, 2-isopropyl-	5	Armyworm	Third instar	Moderate	-	42
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	-	0
	5	Two-spotted spider mite	do.	-	-	94
	1	do.	do.	-	-	43

Cyclohexanol, 4-isopropyl-	5	Armyworm	Third instar	None	-	93
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	-	19
	5	Two-spotted spider mite	do.	-	-	100

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after--	
					1 day	2 days
<u>In acetone</u>						
Cyclohexanol, 2-phenyl-	5	Armyworm	Third instar	Slight	-	83
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	0	-
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	46
Cyclohexanol, 2-sec-butyl-	5	Armyworm	Third instar	Moderate	-	80
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	-	13
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	0
Cyclohexanol, 4-sec-butyl-	5	Armyworm	Third instar	None	-	100
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	15
	5	Pea aphid	Adult	-	-	25
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	45
Ethanol, 2 phenoxy -	5	Armyworm	Third instar	Moderate	-	17
	5	Large milkweed bug	Fourth instar	-	-	20
	5	Pea aphid	Adult	-	-	17
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	28
Ethanol, 2-(p-tert- butylphenoxy)	5	Armyworm	Third instar	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0

5	Pea aphid	Adult	-	94
1	do.	do.	-	95
.5	do.	do.	-	29
5	Two-spotted spider mite	do.	-	100
1	do.	do.	-	100
.5	do.	do.	-	44
1-Menthhol				
5	Armyworm	Third instar	Moderate	40
5	Large milkweed bug	Fourth instar	-	5
5	Pea aphid	Adult	14	-
5	Two-spotted spider mite	do.	-	92
1	do.	do.	-	60
1-Naphthol				
5	Armyworm	Third instar	Moderate	52
5	Large milkweed bug	Fourth instar	-	5
5	Pea aphid	Adult	35	-
5	Two-spotted spider mite	do.	-	100
1	do.	do.	-	100
.5	do.	do.	-	100
.1	do.	do.	-	8

In water

1	1-Naphthol, 2,4-dichloro-	Third instar	Slight	60
1	Large milkweed bug	Fourth instar	-	0
1	Pea aphid	Adult	45	-
1	Two-spotted spider mite	do.	-	83
.5	do.	do.	-	14
Phenol				
1	Armyworm	Third instar	Moderate	0
1	Large milkweed bug	Fourth instar	-	10
1	Pea aphid	Adult	-	100 ¹ / ₁
.5	do.	do.	-	100 ¹ / ₁
.1	do.	do.	-	14 ¹ / ₁
1	Two-spotted spider mite	Nymphs and adults	-	35

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
<u>In water</u>						
Phenol, p-(alpha, alpha- dimethylbenzyl)-	1	Armyworm	Third instar	Slight	-	10
	1	Large milkweed bug	Fourth instar	-	-	10
	1	Pea aphid	Adult	-	53	-
	1	Two-spotted spider mite	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	86 1/2
	.05	do.	do.	-	-	47 1/2
Phenol, 2-bromo-4-phenyl-	1	Armyworm	Third instar	Slight	-	63
	1	Large milkweed bug	Fourth instar	-	-	85
	.5	do.	do.	-	57 1/2	0
	1	Pea aphid	Adult	-	-	-
	1	Two-spotted spider mite	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	37
Phenol, 2-bromo-4-tert- butyl-	5	Armyworm	Third instar	None	-	100
	.1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	100
	1	do.	do.	-	-	95
	.1	do.	do.	-	-	45
	5	Pea aphid	Adult	-	100 1/2	-
	.5	do.	do.	-	71 1/2	-
	.1	do.	do.	-	-	54 1/2
	1	Salt-marsh caterpillar	Third instar	Moderate	-	3
	5	Two-spotted spider mite	Adult	-	-	100
	1	do.	do.	-	-	92
	.5	do.	do.	-	-	85
	.1	do.	do.	-	-	16

Phenol, o-bromo-	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	50
	1	Pea aphid	Adult	-	-	92
	.5	do.	do.	-	68	-
	1	Two-spotted spider mite	Nymphs and adults	-	-	100
	.5	do.	do.	-	-	58
Phenol, p-bromo-	1	Armyworm	Third instar	Moderate	-	10
	1	Large milkweed bug	Fourth instar	-	-	85
	.5	do.	do.	-	-	20
	.5	Pea aphid	Adult	-	- ^{1/}	100 ^{1/}
	.1	do.	do.	-	84 ^{1/}	-
	.1	do.	do.	-	43 ^{1/}	-
	1	Two-spotted spider mite	Nymphs and adults	-	-	87
	.5	do.	do.	-	-	75
	.1	do.	do.	-	-	44

In acetone

Phenol, p, p'-2-butylidene-	5	Armyworm	Third instar	Much	-	0
di-(dipropionate)	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	-	12
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	65
Phenol, 2-chloro-4-phenyl-	5	Armyworm	Third instar	Slight	-	87
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	23	-
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	37

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
<u>In water</u>						
Phenol, <u>o</u> -chloro-	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	45
	1	Pea aphid	Adult	-	-	90 $\frac{1}{2}$
	.5	do.	do.	-	100 $\frac{1}{2}$	-
	.1	do.	do.	-	24 $\frac{1}{2}$	-
	1	Two-spotted spider mite	Nymphs and adults	-	-	70
	.5	do.	do.	-	-	53
Phenol, <u>p</u> -chloro-	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	90
	.5	do.	do.	-	-	50 $\frac{1}{2}$
	1	Pea aphid	Adult	-	-	84 $\frac{1}{2}$
	.5	do.	do.	-	100 $\frac{1}{2}$	-
	.1	do.	do.	-	50 $\frac{1}{2}$	-
	1	Two-spotted spider mite	Nymphs and adults	-	-	96
Phenol, <u>o</u> -cyclohexyl-	.5	do.	do.	-	-	83
	.1	do.	do.	-	-	0
	1	Armyworm	Third instar	Slight	-	73
	.5	do.	do.	Moderate	-	50
	1	Large milkweed bug	Fourth instar	-	-	90
	.5	do.	do.	-	-	85
	.1	do.	do.	-	-	0
	1	Pea aphid	Adult	-	71	-
	1	Two-spotted spider mite	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	14

<u>In acetone</u>					
Phenol, 2,6-dibromo-4-tert-butyl-	5	Armyworm	Third instar	Moderate	7
	5	Large milkweed bug	Fourth instar	-	0
	5	Pea aphid	Adult	-	86
	5	Two-spotted spider mite	do.	-	100
	1	do.	do.	-	94
	.5	do.	do.	-	94
	.1	do.	do.	-	39
Phenol, 2,4-dichloro-6-phenyl-	5	Armyworm	Third instar	Much	3
	5	Large milkweed bug	Fourth instar	-	0
	5	Pea aphid	Adult	-	38
	5	Two-spotted spider mite	do.	-	100
	1	do.	do.	-	100
	.5	do.	do.	-	92
	.1	do.	do.	-	65
<u>In water</u>					
Phenol, 2,4-dichloro-	1	Armyworm	Third instar	Slight	13
	1	Large milkweed bug	Fourth instar	-	80
	.5	do.	do.	-	85
	.1	do.	do.	-	0
	1	Pea aphid	Adult	-	58
	1	Two-spotted spider mite	do.	-	100
	.5	do.	do.	-	79
	.1	do.	do.	-	29 ^{1/}
<u>In acetone</u>					
Phenol, 2,4-dinitro-6-phenyl-	5	Armyworm	Third instar	Slight	100
	1	do.	do.	do.	97
	.5	do.	do.	Moderate	93
	.1	do.	do.	do.	13
5		Large milkweed bug	Fourth instar	-	5

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after--	
					1 day	2 days
<u>In acetone</u>						
Phenol, 2,4-dinitro- phenyl-(continued)	5	Pea aphid	Adult	-	-	84
	1	do.	do.	-	-	34
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	94
	.1	do.	do.	-	-	100
	.05	do.	do.	-	-	96
	.01	do.	do.	-	-	62
Phenol, 2,4-di-tert-butyl- 6-isopropyl-	5	Armyworm	Third instar	Slight	-	87
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	0	-
	1	Two-spotted spider mite	do.	-	-	0
Phenol, m-ethyl-	5	Armyworm	Third instar	Slight	-	93
	1	do.	do.	Much	-	7
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	0	-
Phenol, o-isopropyl-	1	Two-spotted spider mite	do.	-	-	0
	5	Armyworm	Third instar	None	-	100
	1	do.	do.	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	0
Phenol, p-isopropyl-	5	Pea aphid	Adult	-	-	25
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	30
Phenol, p-isopropyl-	1	Armyworm	Third instar	Much	-	3
	5	Large milkweed bug	Fourth instar	-	-	5

	5	Two-spotted spider mite	Adult	-	95
	.5	do.	do.	-	42
<u>In water</u>					
Phenol, o-nitro-	1	Armyworm	Third instar	Slight	60
	.5	do.	do.	Moderate	13
	1	Large milkweed bug	Fourth instar	-	40
	1	Pea aphid	Adult	-	48 ¹ / ₂
	1	Two-spotted spider mite	Nymphs and adults	-	100
	.5	do.	do.	-	40
	.1	do.	do.	-	21
<u>In acetone</u>					
Phenol, p-nonyl-	5	Armyworm	Third instar	Slight	90
	1	do.	do.	Much	0
	5	Large milkweed bug	Fourth instar	-	0
	5	Pea aphid	Adult	-	25
	5	Two-spotted spider mite	do.	-	100
	1	do.	do.	-	100
	.5	do.	do.	-	93
	.1	do.	do.	-	62
Phenol, pentabromo-	5	Armyworm	Third instar	Slight	100
	1	do.	do.	do.	97
	.5	do.	do.	Moderate	23
	5	Large milkweed bug	Fourth instar	-	0
	5	Pea aphid	Adult	-	3
	5	Salt-marsh oaterpillar	Third instar	Much	0
	5	Two-spotted spider mite	Adult	-	100
	1	do.	do.	-	87
	.5	do.	do.	-	100
	.1	do.	do.	-	93
	.05	do.	do.	-	78
Phenol, pentachloro-	5	Armyworm	Third instar	None	100
	1	do.	do.	do.	100
	.5	do.	do.	do.	100
	.1	do.	do.	do.	0

Table 3.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
<u>In acetone</u>						
Phenol, pentachloro-(continued)	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	0	-
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	100
	.05	do.	do.	-	-	94
	.01	do.	do.	-	-	18
	5	Armyworm	Third instar	None	-	100
	1	do.	do.	Much	-	3
	5	Large milkweed bug	Fourth instar	-	-	5
Phenol, <u>o</u> -phenyl-	5	Pea aphid	Adult	-	0	-
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	33
	5	Armyworm	Third instar	Moderate	-	3
	5	Large milkweed bug	Fourth instar	-	-	0
	5	Pea aphid	Adult	-	-	17
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
.5	do.	do.	-	-	41	
<u>In water</u>						
Phenol, 4-tert-butyl-2-chloro-	1	Armyworm	Third instar	None	-	100
	.5	do.	do.	Much	-	0
	1	Large milkweed bug	Fourth instar	-	-	80
	1	Pea aphid	Adult	-	88 1/2	-
	.5	do.	do.	-	70 1/2	-

Phenol, <u>p</u> -tert-butyl-	1	Salt-marsh caterpillar	Third instar	Much	3
	1	Two-spotted spider mite	Adult	-	91
	.5	do.	do.	-	90
	.1	do.	do.	-	52
	1	Armyworm	Third instar	None	100
	.5	do.	do.	Much	0
	1	Large milkweed bug	Fourth instar	-	100
	.5	do.	do.	-	100
	.1	do.	do.	-	40
	1	Pea aphid	Adult	-	-
	.1	do.	do.	-	94 1/2
	1	Salt-marsh caterpillar	Third instar	Much	73 1/2
	1	Two-spotted spider mite	Adult	-	0
	.5	do.	do.	-	100
	.1	do.	do.	-	89
				-	9
Phenol, 2,3,4,6-tetra-chloro-	5	Armyworm	Third instar	None	100
	1	do.	do.	Slight	73
	.5	do.	do.	Much	10
	5	Large milkweed bug	Fourth instar	-	95
	1	do.	do.	-	5
	5	Pea aphid	Adult	-	70
	1	Salt-marsh caterpillar	Third instar	Moderate	0
	5	Two-spotted spider mite	Adult	-	100
	1	do.	do.	-	100
	.5	do.	do.	-	100
	.1	do.	do.	-	83
	.05	do.	do.	-	45

In acetone

Propylene acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 days	2 days
<u>In acetone</u>						
Phenol, 2,4,6-trichloro-	5	Armyworm	Third instar	Slight	-	57
	5	Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Adult	-	-	26
	5	Two-spotted spider mite	do.	-	-	100
	1	do.	do.	-	-	100
	.5	do.	do.	-	-	89
	.1	do.	do.	-	-	21
<u>In water</u>						
Phenol, 2,4,6-trichloro-	1	Armyworm	Third instar	None	-	100
	.5	do.	do.	Moderate	-	53
	1	Large milkweed bug	Fourth instar	-	-	100
	.5	do.	do.	-	-	25
	1	Pea aphid	Adult	-	-	100
	.5	do.	do.	-	100	100
	.1	do.	do.	-	41	100
	1	Two-spotted spider mite	Third instar	Moderate	-	10
	1	do.	Nymphs and adults	-	-	100
	.5	do.	do.	-	-	100
Phenol, 2,4,6-trichloro-	.1	do.	do.	-	-	70
	.05	do.	do.	-	-	0
	1	Armyworm	Third instar	Slight	-	13
	1	Large milkweed bug	Fourth instar	-	-	30
	1	Pea aphid	Adult	-	-	100
	.5	do.	do.	-	67	100
	.1	do.	do.	-	53	100
	1	Two-spotted spider mite	Nymphs and adults	-	-	100
	.5	do.	do.	-	-	100
	.1	do.	do.	-	-	36

Pyrocatechol (dipropionate)	1	Armyworm	Third instar	Moderate	-	0
	1	Large milkweed bug	Fourth instar	-	-	10
	1	Pea aphid	Adult	-	1001/	-
	.5	do.	do.	-	69	-
	1	Two-spotted spider mite	do.	-	-	21

1/ Dipped.

Table 4.--Propionates causing more than 74 percent mortality of one or more species of insects when tested as dusts

Propionic acid ester with	Percent	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
Percent						
Benzophenone, 2,4'-di- hydroxy-(dipropionate)	10	Armyworm	Third instar	Much	-	0
		Celery leaf tier	do.	None	-	100
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
Benzophenone, 4,4'-di- droxy-(dipropionate)	10	Armyworm	Third instar	Moderate	-	7
		Celery leaf tier	do.	Slight	-	69
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	17
m-Cresol, 6-tert-butyl-	10	Armyworm	Third instar	Moderate	-	23
		Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	89
1,5-Naphthalenediol (dipropionate)	10	Armyworm	Third instar	Moderate	-	0
		Celery leaf tier	do.	-	-	75
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
2-Naphthol	10	Armyworm	Third instar	Moderate	-	0
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Second instar	-	100	-
	5	do.	Adult	-	29	-
	10	Two-spotted spider mite	Nymphs and adults	-	-	67

Phenol, 2-bromo-4-tert-butyl-	10	Armyworm	Third instar	Moderate	-	13
		Celery leaf tier	do.	None	-	100
		Large milkweed bug	Fourth instar	-	-	10
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	4
Phenol, p-cyclohexyl-	10	Armyworm	Third instar	Moderate	-	0
		Celery leaf tier	do.	Slight	-	92
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	14
Phenol, m-ethyl-	10	Armyworm	Third instar	Moderate	-	0
		Celery leaf tier	do.	Slight	-	100
		Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
Phenol, p-ethyl-	10	Armyworm	Third instar	Much	-	0
		Celery leaf tier	do.	Slight	-	75
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
Phenol, p-nitro-	10	Armyworm	Third instar	Moderate	-	3
		Large milkweed bug	Fourth instar	-	-	5
	5	Pea aphid	Second instar	-	100	-
	1	do.	Adult	-	79	-
	10	Two-spotted spider mite	do.	-	41	-
			Nymphs and adults-			55

1 / 1 gram dispersed in vacuum duster.

Table 4.---(Continued)

Propionic acid ester with $\sqrt{}$	Percent	Insect	Stage	Feeding	Average percent kill after--	
					1 day	2 days
Phenol, pentachloro-	10	Armyworm	Third instar	None	-	100
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	50	-
		Two-spotted spider mite	do.	-	-	100
Phenol, o-phenyl-	10	Armyworm	Third instar	Much	-	3
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	100
Phenol, 2,3,4,6-tetrachloro-	10	Armyworm	Third instar	None	-	100
		Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	19	-
		Two-spotted spider mite	do.	-	-	100

$\sqrt{}$ 1 gram dispersed in vacuum duster.

Table 5.--Propionates causing less than 75 percent mortality of any species of insect when tested as 10-percent dusts

Propionic acid ester with $\frac{1}{2}$	Insect	Stage	Feeding	Average percent kill after	
				1 day	2 days
<u>m</u> -Cresol, 6-amyl-	Armyworm	Third instar	Moderate	-	43
	Celery leaf tier	do.	do.	-	8
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
<u>p</u> -Cresol, 2-nitro-	Armyworm	Third instar	Moderate	-	0
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
<u>o</u> -Cresol, 4-tert-butyl-	Armyworm	Third instar	Moderate	-	23
	Celery leaf tier	do.	do.	-	8
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
<u>p</u> -Cresol, 2-tert-butyl-	Armyworm	Third instar	Moderate	-	40
	Celery leaf tier	do.	do.	-	13
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
Cyclohexaneethanol	Armyworm	Third instar	Moderate	-	0
	Pea aphid	Adult	-	0	-

$\frac{1}{2}$ 1 gram dispersed in vacuum duster.

Table 2.--(Continued)

Propionic acid ester with	Insect	Stage	Feeding	Average percent kill after--	
				1 day	2 days
Cyclohexanol, 2-iso- propyl-	Armyworm	Third instar	Moderate	-	0
	Pea aphid	Adult	-	0	-
	Armyworm	Third instar	Moderate	-	0
	Pea aphid	Adult	-	0	-
Cyclohexanol, 2-phenyl-	Armyworm	Third instar	Moderate	-	0
	Large milkweed bug	Fourth instar	-	-	5
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
Cyclohexanol, 2-sec- butyl-	Pea aphid	Adult	-	0	-
Bisphenol	Armyworm	Third instar	Much	-	0
	Celery leaf tier	do.	Moderate	-	42
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	9
	Armyworm	Third instar	Moderate	-	0
Guaiacol	Celery leaf tier	do.	do.	-	13
	Large milkweed bug	Fourth instar	-	-	5
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
	Armyworm	Third instar	Moderate	-	0
	Celery leaf tier	do.	do.	-	0
Hydroquinone (dihydroxybenzene)	Large milkweed bug	Fourth instar	-	-	16
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	16
	Armyworm	Third instar	Moderate	-	0
	Celery leaf tier	do.	do.	-	0
	Large milkweed bug	Fourth instar	-	-	16

1-Menthol	Amyworm	Third instar	Moderate	-	0
	Celery leaf tier	do.	do.	-	17
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
1-Naphthol	Amyworm	Third instar	Moderate	-	0
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	18	-
	Two-spotted spider mite	do.	-	-	69
Phenol, 2-chloro-4-phenyl-	Amyworm	Third instar	Moderate	-	0
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	68
Phenol, o-isopropyl-	Amyworm	Third instar	Moderate	-	0
	Pea aphid	Adult	-	0	-
Phenol, p-isopropyl-	Amyworm	Third instar	Moderate	-	0
	Celery leaf tier	do.	do.	-	38
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0
Phenol, p-methoxy-	Amyworm	Third instar	Much	-	0
	Celery leaf tier	do.	Moderate	-	17
	Large milkweed bug	Fourth instar	-	-	10
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	30
Phenol, p-nonyl-	Amyworm	Third instar	Moderate	-	3
	Pea aphid	Adult	-	0	-

1/ 1 gram dispersed in vacuum duster.

Table 6.---(Continued)

Propionic acid ester with	Insect	Stage	Feeding	Average percent still active	
				1 day	2 days
Phenol, p-phenyl-	Armyworm	Third instar	Much	-	0
	Large milkweed bug	Fourth instar	-	-	15
	Pea aphid	Adult	-	15	-
	Two-spotted spider mite	do.	-	-	70
Phenol, 2,4-di-tert- butyl-5-isopropyl-	Armyworm	Third instar	Moderate	-	3
	Celery leaf tier	do.	do.	-	17
	Large milkweed bug	Fourth instar	-	-	0
	Pea aphid	Adult	-	0	-
Phenol, 2-tert-butyl- 5-isopropyl-	Two-spotted spider mite	do.	-	-	0
	Armyworm	Third instar	Moderate	-	33
	Celery leaf tier	do.	do.	-	15
	Large milkweed bug	Fourth instar	-	-	10
	Pea aphid	Adult	-	0	-
	Two-spotted spider mite	do.	-	-	0

1/ 1 gram dispersed in vacuum dust.

Table 6.--Propionates causing less than 75 percent mortality of any species of insect when used as acetone sprays

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after-	
					1 day	2 days
Benzophenone, 2,4'-dihydroxy-(dipropionate)	5	Armyworm	Third instar	Much	-	0
		Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	6	-
	1	Two-spotted spider mite	do.	-	-	7
Benzophenone, 4,4'-dihydroxy-(dipropionate)	5	Armyworm	Third instar	Much	-	0
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
<u>m</u> -Cresol, 6- <u>amyl</u> -	1	Armyworm	Third instar	Much	-	10
	5	Large milkweed bug	Fourth instar	-	-	10
		Pea aphid	Adult	-	0	-
	1	Two-spotted spider mite	do.	-	-	0
<u>o</u> -Cresol, 4- <u>tert</u> -butyl-	1	Armyworm	Third instar	Much	-	3
	5	Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	0	-
	1	Two-spotted spider mite	do.	-	-	0
Eugenol	1	Armyworm	Third instar	Much	-	0
	5	Large milkweed bug	Fourth instar	-	-	10
		Pea aphid	Adult	-	5	-
	1	Two-spotted spider mite	do.	-	-	0

Table 6.--(Continued)

Propionic acid ester with	Percent concentration	Insect	Stage	Feeding	Average percent kill after--	
					1 day	2 days
Guaiacol	5	Armyworm	Third instar	Much	-	13
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	62
Hydroquinone(dipropionate)	5	Armyworm	Third instar	Much	-	13
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0
1,5-Naphthalenediol, (dipropionate)	5	Armyworm	Third instar	Moderate	-	20
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	49
Phenol, p-cyclohexyl-	5	Armyworm	Third instar	Much	-	33
		Large milkweed bug	Fourth instar	-	-	5
		Pea aphid	Adult	-	22	-
		Two-spotted spider mite	do.	-	-	10
Phenol, p-ethyl-	1	Armyworm	Third instar	Much	-	7
		Large milkweed bug	Fourth instar	-	-	0
		Pea aphid	Adult	-	10	-
		Two-spotted spider mite	do.	-	-	0
Phenol, p-methoxy-	5	Armyworm	Third instar	Much	-	3
		Large milkweed bug	Fourth instar	-	-	10
		Pea aphid	Adult	-	0	-
		Two-spotted spider mite	do.	-	-	0

Phenol, 2-tert-butyl-6-isopropyl-	1	Armyworm	Third instar	Much	17
	5	Large milkweed bug	Fourth instar	-	5
		Pea aphid	Adult	0	-
	1	Two-spotted spider mite	do.	-	0
<u>In water</u>					
Hydroquinone, 2,5-di-tert-butyl-(dipropionate)	1	Armyworm	Third instar	Moderate	0
		Large milkweed bug	Fourth instar	-	0
		Pea aphid	Adult	62	-
		Two-spotted spider mite	do.	-	24

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